Auction Description Language (ADL): a General Framework for Representing Auction-based Markets

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A huge volume of goods and services are sold through auctions. Typically, an auction-based market is described by a set of rules stating what are the available actions to the participants, how the winner is determined, and what price should be paid by the winner. There are variants where multiple winners could be considered or payment may also concern the losers. Actually, an Auction protocol may differ in numerous aspects: single or double-side, ascending or descending, single or multi-unit goods, and so on [3].

This great variety of auction protocols prevents any autonomous agent to easily switch between different auction based-markets [6]. Having a language for describing auctions from a general perspective is then at first interest. This language should also allow the reasoning about the key issues of a specific market, namely the allocation and payment rules. Participants may be able to process the auction definition and, consequently, define their bids wrt. these rules.

The goal of this talk is to present a logical language for representing and reasoning about the rules governing an auction-based market. Our approach is based on the Game Description Language (GDL) which is a logic-based language for representing and reasoning about game rules; GDL is the official language for the *General Game Playing* challenge [2]. We revisit the GDL variant proposed in [8] and define the logical *Auction Description Language*: we allow numerical variables, comparison and parameters at the opposite of GDL. Handling numerical values is critical for defining the payment and allocation rules.

Related work To the best of our knowledge, almost all contributions on the computational representation of auction-based markets focus on their implementation. In [5], the authors propose an assertive and modular definition of an auction market by representing the market as a set of rules. These rules tackle at first the how and when to bid and assume a single-agent perspective. There is no general reasoning as the semantics is an operational one. The language proposed in [6] adopts an assertive perspective: the proposed language allows the representation of a general auction market, but it is too poor for enabling reasoning. In [1], the authors show how a specific auction, namely combinatorial auctions, can be encoded in a logic program. A hybrid approach mixing linear programming and logic programming has been proposed in [4]: the authors focus on sealed-bid auctions and show how qualitative reasoning helps to refine the optimal quantitative solutions. The closest contribution is the *Market Specification Language* [7] based on the *Game Description Language* (GDL) [2]. The proposed language is rich enough for representing an auction through a set of rules and then interpreting an auction-instance with the help of a state-based semantics. However, the main limit is the single-agent perspective.

Contribution In this talk, we focus on single-side auctions: that is one seller and multiple buyers or vice-versa. The language is general enough for taking care of goods' quantity (single or multi-unit) and whether it is open or not (sealed-bid). We focus on the auctioneer perspective: how the auction is organized, how the goods are allocated and how to know if the auction is complete. ADL is appropriate to represent different types of well-known auctions, such as the English Auction and the Multi-Unit Vickrey Auction. For instance, consider the following ADL rules describing the payment and bidding value update for an English Auction:

1. $payment(r, x) \leftrightarrow wins(r) \wedge Bid(x)$
2. $\bigcirc Bid(add(x, inc)) \leftrightarrow Bid(x) \wedge \bigvee_{r \in N_{eng}} does(accept^r)$

Rule 1 states that a bidder r will pay value x if and only if she wins the auction and x is the current bid value. Rule 2 specifies how the bidding value is updated in each round: in the next state, the bid value will be raised by *inc* only if at least one agent accepted to keep bidding. ADL allow us to derive properties about auction protocols, such as its finiteness and the uniqueness of payment and winner. It also enables us to show in an explicit way what should be assumed about the behavior of a rational bidder, i.e. a player with a private value for the good being auctioned and who tries to maximize a payoff function. For instance, we are able to show that a rational bidder would keep bidding in an English Auction, as long as the bidding value is smaller then her private value.

Perspectives During my thesis, there are two main tracks I intend to explore. First, from the auctioneer point of view, my goal is to go explore two main variants of auctions: double-side auction and combinatorial auction [3]. Clearly, ADL is well suited for both of them but requires some extension. Multiple sorts of goods are not yet possible for instance. Second, I want to investigate how ADL-based players may be implemented so that they can reason about the properties of an auction such as the strategy-proof aspect. The key difference, when the player perspective is considered, is the epistemic and strategic aspects: players have to reason about other players' behavior.

References

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